Alytes, 1999, **16** (3-4): 165-189.

Geographic variation of *Hyla rubicundula* and *Hyla anataliasiasi*, with the description of a new species (Anura, Hylidae)

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Analyses of intra- and interpopulation variation of the external morphology of *Hyla rubicundula* Reinhardt & Lütken, 1862 and *Hyla anataliasiasi* Bokermann, 1972 indicate that four morphospecies are represented. *Hyla rubicundula* comprises three of the four morphospecies. Its northern morphospecies is described as a new species characterized by an immaculate dorsum and a pointed snout. Redescriptions of *H. rubicundula* and *H. anataliasiasi* are provided.

INTROD UCTION

The species currently included in the *Hyla rubicundula* group share the following characteristics: small size (SVL: males 16.0-25.5 mm, females 16.6-25.9 mm), thighs immaculate, dorsum consistently green in life, and dorsal surfaces pink to violet in preservative. This group occurs in northern, central, northeastern and southeastern Brazil (FROST, 1985), in open habitats, mainly in "cerrado" formations, but also in transitional areas between cerrado and rainforests.

According to BOKERMANN (1968) and FROST (1985), the *Hyla rubicundula* group is composed of *Hyla rubicundula* Reinhardt & Lutken, 1862, *Hyla tritaeniata* Bokermann, 1965 and *Hyla anataliasiasi* Bokermann, 1972. *Hyla elongata* A. Lutz, 1925 was synonymized with *H. rubicundula* by BOKERMANN (1968) but treated as a valid species by HADDAD et al. (1988); the latter authors compared vocalizations of specimens from Serra da Canastra, Minas Gerais, with the vocalizations of topotypic populations of *H. rubicundula* described by CARDOSO & VIELLIARD (1985), and considered *H. rubicundula* and *H. elongata* as distinct species. However, our examination of the external morphology of the specimens from Serra da Canastra revealed that they must be associated to the *H. tritaeniata* complex, and were wrongly identified as *H. elongata* by HADDAD et al. (1988). Thus, the synonymization *of H. elongata* with *H. rubicundula* proposed by BOKERMANN (1968) is valid

Hyla tritaeniata, originally included in the *H. rubicundula* group, is not treated in this paper because it has (1) a distinctive dorsal pattern (a single sacral stripe, instead of two in the other species) and (2) different habitat preferences: this species is found in springs and streams, whereas the rest of the group inhabits permanent or temporary ponds (BOKERMANN, 1965, JIM, 1980). Also, (3) the large intra- and interpopulation variations of *H. tritaeniata* suggest a species complex that must be analyzed separately.

The purposes of this paper are (1) to study the degree of intra- and interpopulation variation in *H. rubicundula* and *H. anataliasiasi*, and (2) to describe a new species of the *H. rubicundula* species group.

MATERIAL AND METHODS

Specimens used for description or examined for comparisons were previously deposited in the collections of the Museu Nacional, Rio de Janeiro (MNRJ), of the Museu de Zoologia, Universidade de São Paulo (MZUSP), of the Naturhistorisches Museums, Vienna (NMW), of the Werner C. A. BOKERMANN collection, deposited in the Museu de Zoologia, Universidade de São Paulo, SP, Brazil (WCAB), of the Kobenhavns Universitet, Zoologisk Museum, Copenhagen (ZMUC), and of the Museu de História Natural, Universidade Estadual de Campinas (ZUEC). The analysis of the material was similar to that used by VANZOLINI (1970) and HEYER (1984). Initially, large samples from each locality were analyzed ("basic samples") to determine the patterns of variation within samples. Specimens were sorted into morphospecies (i.e., categories thought to represent different species). Subsequently, samples from poorly represented localities were analyzed ("small samples"), and these specimens, when possible, were associated to a morphospecies by similar morphology and proximity among localities. The last step of the analysis corresponds to a careful examination of the patterns of variation among morphospecies.

Only adult males were examined because females and juveniles were rare in the samples. We developed a series of standards for the general dorsal pattern, mid-dorsal pin stripe, dorsolateral stripes, lateral limits of dorsum, upper surface of tibia, loreal and canthal stripes, and dorsal head shape (fig. 1-3). Nine measurements (mm) were taken following DUELLMAN (1970): SVL (snout-vent length), HL (head length), HW (head width), ED (eye diameter), UEW (upper eyelid width), IOD (interorbital distance), IND (internarial distance), TD (tympanum diameter) and TL (tibia length). Four measurements were made following HEYER et al. (1990): UAR (upper arm), FAR (forearm), HAL (hand length) and THL (thigh length). Five other measurements were END (eye to nostril distance: straight line distance between anterior corner of orbital opening and posterior margin of external nare), NSD (nostril to tip of snout distance: straight line distance between anterior corner of nostril to tip of snout), FL (foot length: distance from heel to tip of fourth toe), 3FD (third finger disk diameter: greatest horizontal distance between outer edges of third finger disk) and 4TD (fourth toe disk diameter: greatest horizontal distance between outer edges of fourth toe disk). Webbing formula notations followed SAVAGE & HEYER (1967).

Discriminant function analyses compared inter- and intra-morphospecies variation (MARCUS, 1990) without removing the size effect in the groups (REIS et al., 1990), and groups

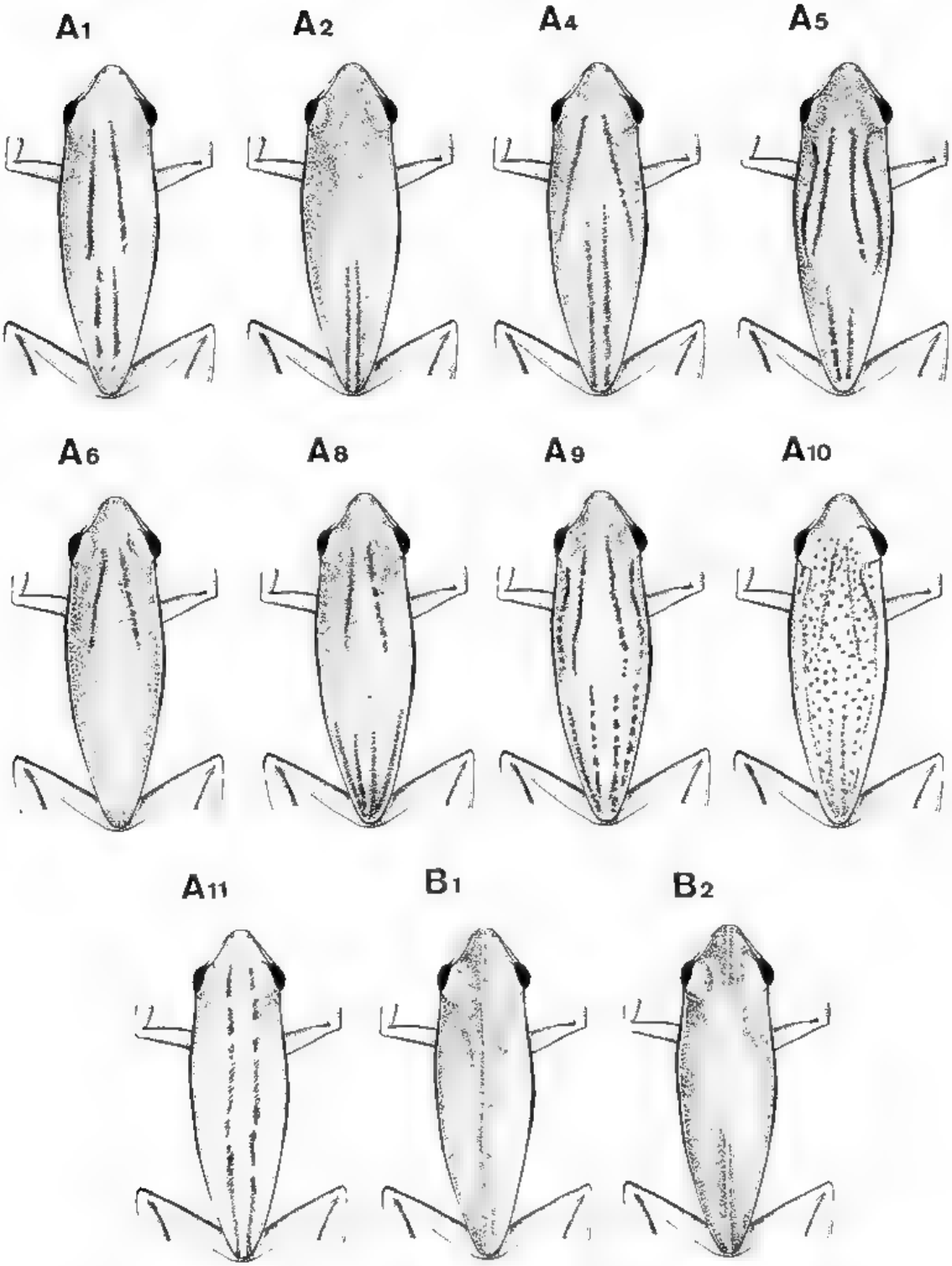


Fig 1 Standards for dorsal and mid-dorsal pin stripe patterns. Patterns A3 (dorsum immaculate), A7 (one to few dots distributed irregularly) and B3 (absence of mid-dorsal pin stripe) are not figured

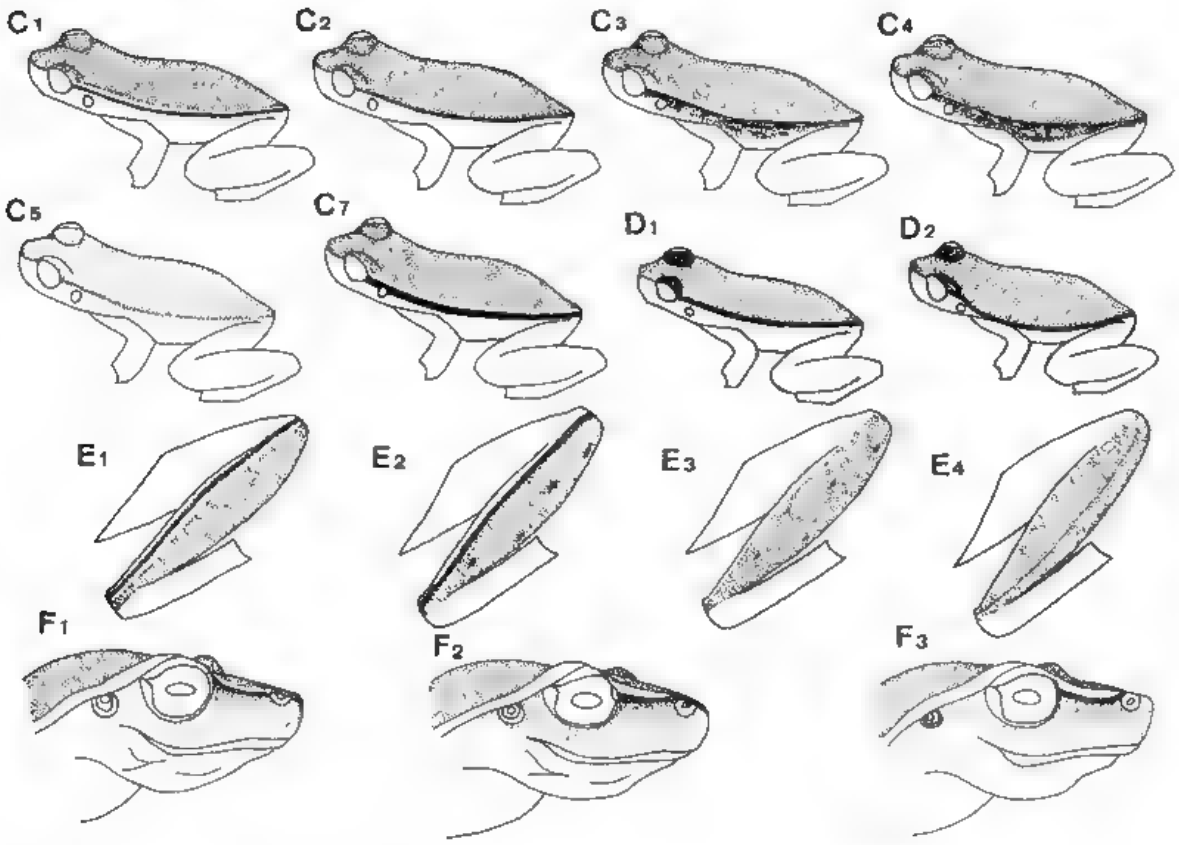
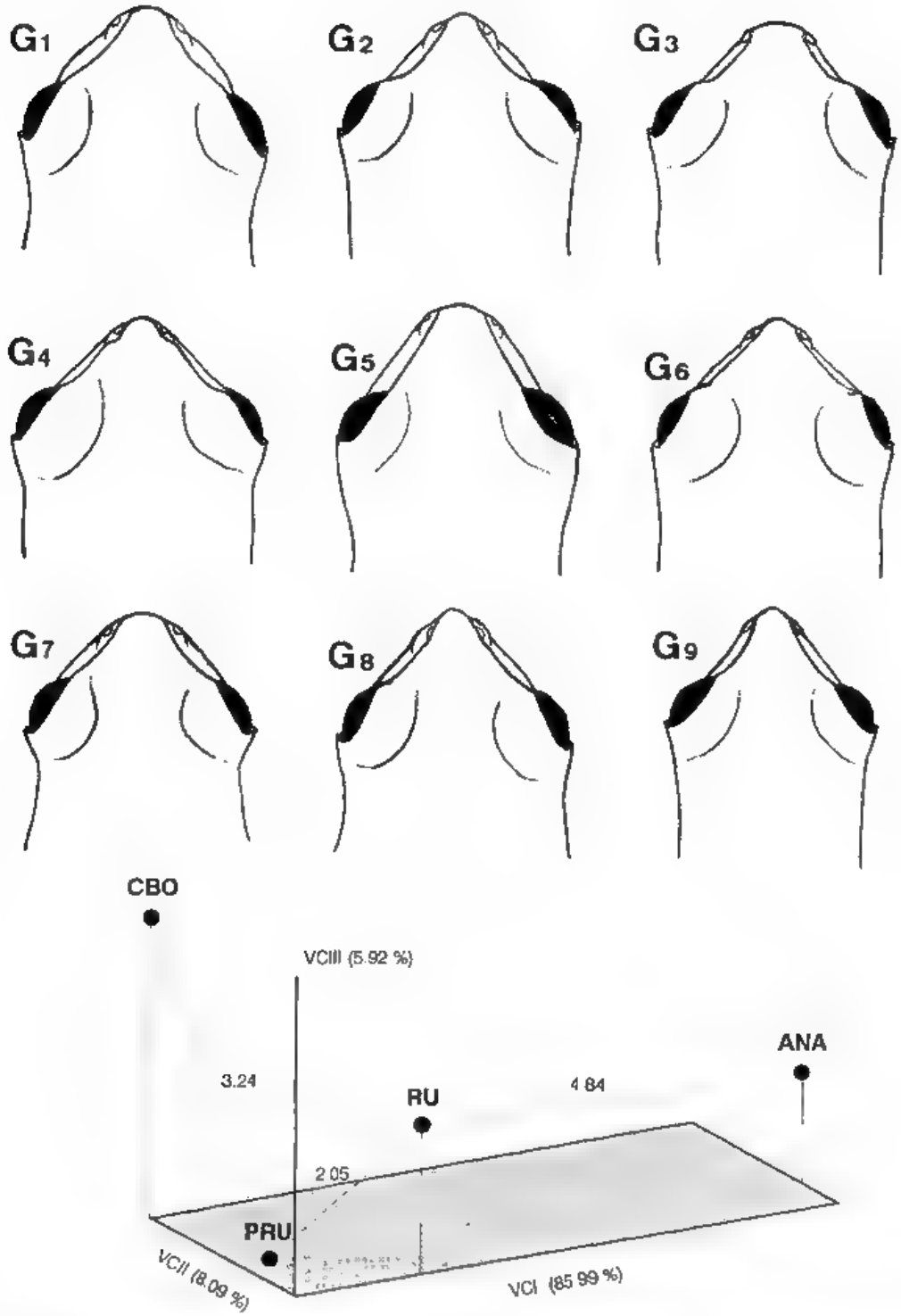


Fig. 2 - Standards for dorsolateral stripes: C1-C2, thin and regular; C3-C4, thick and irregular; C5, vestigial; C6, absent, is not figured, C7, thick and well marked. Lateral limits of dorsum: D1, above the tympanum; D2, under the lower border of tympanum. Upper surface of tibia patterns. E1, white stripe over dark stripe; E2, white stripe absent, E3, white and dark stripes vestigial or absent, E4, presence of a mid-dorsal pin stripe. Loreal and canthal stripes patterns F1, thin white stripe over dark stripe; F2-F3, thick clear band over dark stripe.

were defined a priori. Eigenvectors and associated eigenvalues were obtained from a variance-covariance matrix, and the loadings were the correlations between the original variables and the scores. We used *t*-tests to compare mean values from different measurement variables of the same species. For character analyses, we used the chi-square test (χ^2) to compare patterns among samples of the same morphospecies (SOKAL & ROHLF, 1981)

Vocalizations were recorded by Rogério P. BASTOS with a Uher Report Monitor and a Uher M 518 A microphone at a tape speed of 19 cm/s. Tapes were analyzed on a Macintosh Classic coupled to a MacRecord Sound System 2.0.5



F.g 3 Standards for the dorsal head shape patterns (G1-G7), and projection of centroids resulted from the multiple discriminant function analysis for 18 morphometric characters of the combined samples of morphospecies RU, PRU, CBO and ANA, in the first three canonical axes. A minimum spanning tree connects the closest means, and the Mahalanobis distance is given for each link of the tree, this procedure corrects the distortion caused by the three-dimensional projection

Results and discussion

Morphospecies

The four morphospecies were named and coded as follows (code, code name, number of specimens analyzed, localities):

RU, *Hyla rubicundula*, $n = 144$. Bahia: Barreiras and Jupaguá. Minas Gerais: Alfenas, Andrequicé, Arinos, Barão de Cocais, Belo Horizonte, Buritis, Buritizeiro, Esmeraldas, Jaboticatubas, Januária, Lagoa Formosa, Lagoa Santa, Manga, Pirapora, Três Marias, Unai and Vespasiano. Goiás: Cristalina.

PRU, *Hyla* "pseudorubicundula", $n = 54$ Minas Gerais: Uberlândia. Goiás. Aragarças, Cavalcante, Goiânia, Iaciara, Monte Alegre de Goiás, Nova Roma, Porangatu, Santa Rita do Araguaia, São Domingos and escarpa da Serra Dourada. Piauí: Uruçui.

CBO, "Cachimbo", $n = 15$. Pará: Cachimbo.

ANA, *Hyla anataliasiasi*, $n = 85$. Mato Grosso Posto Leonardo and Posto Diauarum.

Comparisons among morphospecies

Results from the analysis of the seven coloration patterns indicate two categories of characters (tab. 1). In the first category, frequencies of character states differed among morphospecies, but no states (e.g., mid-dorsal pin stripe or loreal and canthal stripes patterns) were diagnostic. The second category was defined by states unique to certain morphospecies, and specimens having such unique states were easily diagnosed from the other morphospecies (e.g., any specimen that presented pattern A11 for general dorsal pattern was automatically assigned to morphospecies ANA). General dorsal patterns, dorsolateral stripes, lateral limits of dorsum, upper surface of tibia, and dorsal head shape patterns belonged to this category. Taken in combination, pattern characteristics distinguished most but not all individuals of the four morphospecies; that is, a specimen that had only character states common to all morphospecies was not assigned to one of them.

Measurement variables

Multiple discriminant function analysis was used to analyze morphological variation among the four morphospecies. We found three significant axes (Wilks $\lambda = 0.0753$, $F = 16.86$, $df = 54$ and 659.3, Bonferroni corrected, $P < 0.01$) (fig. 3). Morphospecies ANA and CBO were easily discriminated from morphospecies RU and PRU, but the last two were only partially discriminated from each other (tab. 2). The standardized discriminant function coefficients and the loadings are presented in tab. 3.

Table 1. - Distributions and percentage (in parentheses) of patterns (fig. 1-3) among the four morphospecies. A blank indicates no specimen had that state; a zero indicates that at least one specimen with that state was examined, but the rate of occurrence per 100 specimens rounds off to zero. *n* = number of specimens for which data are available.

General dorsal patterns												
Morphospecies	*n*	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11
RU	132	53 (40)	1 (7)	15 (11)	17 (12)	4 (3)	6 (4)	2 (1)	9 (6)	15 (11)	1 (0)	
PRU	48	16 (33)	4 (8)	1 (25)	2 (4)	2 (4)	1 (2)	1 (2)	2 (4)	7 (14)	1 (2)	
CBO	15			5 (33)				11 (66)				
ANA	81		1 (1)	45 (55)			11 (13)	5 (6)				19 (23)

Mid-dorsal pin stripe					Dorsolateral stripes							
Morphospecies	*n*	B1	B2	B3	*n*	C1	C2	C3	C4	C5	C6	C7
RU	144	64 (43)	32 (21)	48 (33)	132	83 (62)	49 (37)					
PRU	48	2 (4)	10 (20)	36 (75)	46	5 (10)	8 (17)	15 (32)	10 (21)	3 (6)	5 (10)	
CBO	15			15 (100)	15		14 (93)	1 (6)				
ANA	82	36 (43)	20 (22)	26 (31)	81	15 (18)	50 (61)			10 (12)	1 (1)	5 (6)

Lateral limits of dorsum				Upper surface of tibia					Loreal and canthal stripes				
Morphospecies	*n*	D1	D2	*n*	E1	E2	E3	E4	*n*	F1	F2	F3	F4
RU	134	134 (100)		134	91 (67)	37 (26)	6 (3)		140	119 (84)	12 (7)	6 (4)	3 (2)
PRU	48	22 (42)	26 (54)	45	12 (26)	27 (60)	6 (13)		46	4 (8)	22 (47)	14 (30)	6 (13)
CBO	15	15 (100)		15		10 (66)	5 (33)		15		9 (60)	6 (40)	
ANA	82	82 (100)		82	3 (3)		13 (15)	66 (80)	82	40 (46)	4 (4)		38 (46)

Dorsal head shape										
Morphospecies	*n*	G1	G2	G3	G4	G5	G6	G7	G8	G9
RU	140	9 (6)	40 (28)	58 (41)	9 (6)	11 (7)	11 (7)	2 (1)		
PRU	47		5 (10)	2 (4)	1 (2)	1 (2)		38 (80)		
CBO	15								15 (100)	
ANA	82									82 (100)

Variation within morphospecies RU

The analysis examined the samples from Minas Gerais and Bahia. These samples were grouped into four areas equidistantly distributed along a transect (fig. 4A) linking Barreiras (Bahia) and Alfenas (Minas Gerais) that represented, respectively, the distribution limits north and south for morphospecies RU. Distributions of pattern states were determined for each of the four areas, and the observed occurrences were tested against expected occurrences (based on frequency of distribution for entire sample RU) with a chi-square test. Some character states were combined to avoid violating minimum cell-size requirements for χ^2 analysis (app. 1; Sokal & Rohlf, 1981).

Three directional clines were observed (fig 4A). The first direction (shading "A") denoted a cline for general dorsal pattern and upper surface of tibia pattern (fig 5A). These specimens showed an increase in dorsal melanization and a decrease of the dorsolateral white stripe on the edges of tibia from southeastern to northeastern Minas Gerais. The second direction (shading "B") denoted a cline for dorsal head shape (fig. 5A) involving areas I, II and IV. We did not consider area III because it is not representative (the two geographical samples in the direction "B" included only two specimens and neither were well preserved), thus, there is a hiatus between areas II and IV. The third cline followed the transect line. It was characterized by a decrease in occurrence of a mid-dorsal pin stripe (fig. 5A) from south to north (i.e., from area I/II to IV). The patterns of loreal and canthal stripes and dorsolateral stripes did not show statistically significant level variation.

The similarity among these areas depended on each particular character, and there was no specific pattern discriminating an area from the others. However, differentiation may be computed in the degree of occurrence for a certain state. The similarity and dissimilarity among areas shown by each character obtained from the χ^2 test was as follows: general dorsal pattern (I ≈ IV; II ≈ III), mid-dorsal pin stripe pattern (I ≈ II; III ≈ IV), dorsolateral stripes pattern (I ≈ II ≈ III; IV), upper surface of tibia pattern (I ≈ II ≈ IV; III), loreal and canthal stripes pattern (I ≈ IV ≈ II ≈ III), and dorsal head shape (I ≈ III; II ≈ IV).

Measurement variables

Multiple discriminant function analysis was used to analyze morphological variation among nine samples previously combined. To increase the number of specimens analyzed, samples from Três Marias and Andrequicé, Pirapora and Lagoa Formosa, and Vespasiano and Barão de Cocais were combined because of their proximity. Three significant canonical axes (Wilks $\lambda = 0.02385$, $F = 3\,274$, $df = 144$ and 712 6; Bonferroni corrected, $P < 0.0006$) resulting from this analysis represented 79 % of the total variation. The projection of the individual scores in the first three axes (not figured) did not support additional discrimination and made a mosaic of superpositions among the geographic samples. This result may be interpreted as intraspecific variation. All samples were considered to belong to *H. rubicundula*.

VARIATION WITHIN MORPHOSPECIES PRU

This analysis examined samples from Goiás. These were grouped into three areas (fig. 4B) with the same criteria as for morphospecies RU, but the small number of specimens in each sample, mainly in areas I and III, made the use of the χ^2 test (pattern analysis) impossible in most comparisons. The discriminant function analysis used to analyze morphological variation (measurement variables) among five previously combined samples furnished only one significant canonical vector (Bonferroni corrected) without any relevant discrimination result.

Frogs from areas I and II were similar to each other in the majority of characters but were different from those from area III. A cline, characterized by the straight line between Santa Rita do Araguaia and São Domingos (fig. 4B), was observed for (1) dorsolateral stripes (a progressive disappearance of the dorsolateral white stripe from northern to southern Goiás) and (2) dorsal head shape patterns (a decrease of diversity of dorsal head shape patterns from northern to southern Goiás; fig. 5B). The similarity among areas shown for each character, obtained for certain characters by the χ^2 test, is as follows: general dorsal pattern (I ≈ II; III), mid-dorsal pin stripe pattern (I ≈ II; III), dorsolateral stripes pattern (I ≈ II; III), lateral limits of dorsum pattern (I ≈ II; III), upper surface of tibia pattern (I ≈ II; III), loreal and canthal stripes pattern (I, II, III) and dorsal head shape (I ≈ II; III). Differences between areas I and II were mainly by degree of occurrence of some states, rather than kind; area III differed from the others by degree and kind.

TAXONOMIC CONCLUSIONS

Morphospecies RU and PRU were not well discriminated from each other. Pattern standards denoted variation in degree between these morphospecies but not in kind. Such variation occurred for all character similarity between area III of Minas Gerais (fig. 4A) and area I of Goias (fig. 4B). The discrimination obtained by the discriminant function analysis was not robust (tab. 2). Also, the comparisons between advertisement calls of topotypic *Hyla rubicundula* (CARDOSO & VIELLIARD, 1985) (morphospecies RU) and a sample from Silvânia, Goiás (morphospecies PRU, see *Vocalization* in *Hyla rubicundula* redescription below) failed to provide additional support for discrimination.

The distribution of morphospecies PRU in Goiás (central Brazil) deserves consideration. The Serra do Caiapó, Serra Dourada, Serra dos Pirineus and heterogeneous vegetation separate the examined population samples in three areas in northern, southern and eastern Goiás (Goiânia). The vegetation (ANONYMOUS, 1989) is mainly represented by seasonal semi-deciduous forest, seasonal deciduous forest and transitional areas ("ecological stress areas"). Because these frogs never cross tropical rainforests, the discontinuity of cerrado formation in central Brazil, where different kinds of relief and vegetation are found, may reduce or obstruct genetic flow among local populations and favor the formation of heterogeneous morphotypes.

The "Espigão Mestre" (scarps, 1200-3000 m), with tropical rainforests, between Goias and Bahia, as well as the semi-deciduous seasonal forest of southern Goias (ANONYMOUS, 1989) adjacent to Minas Gerais, may function as ecological barriers between populations of

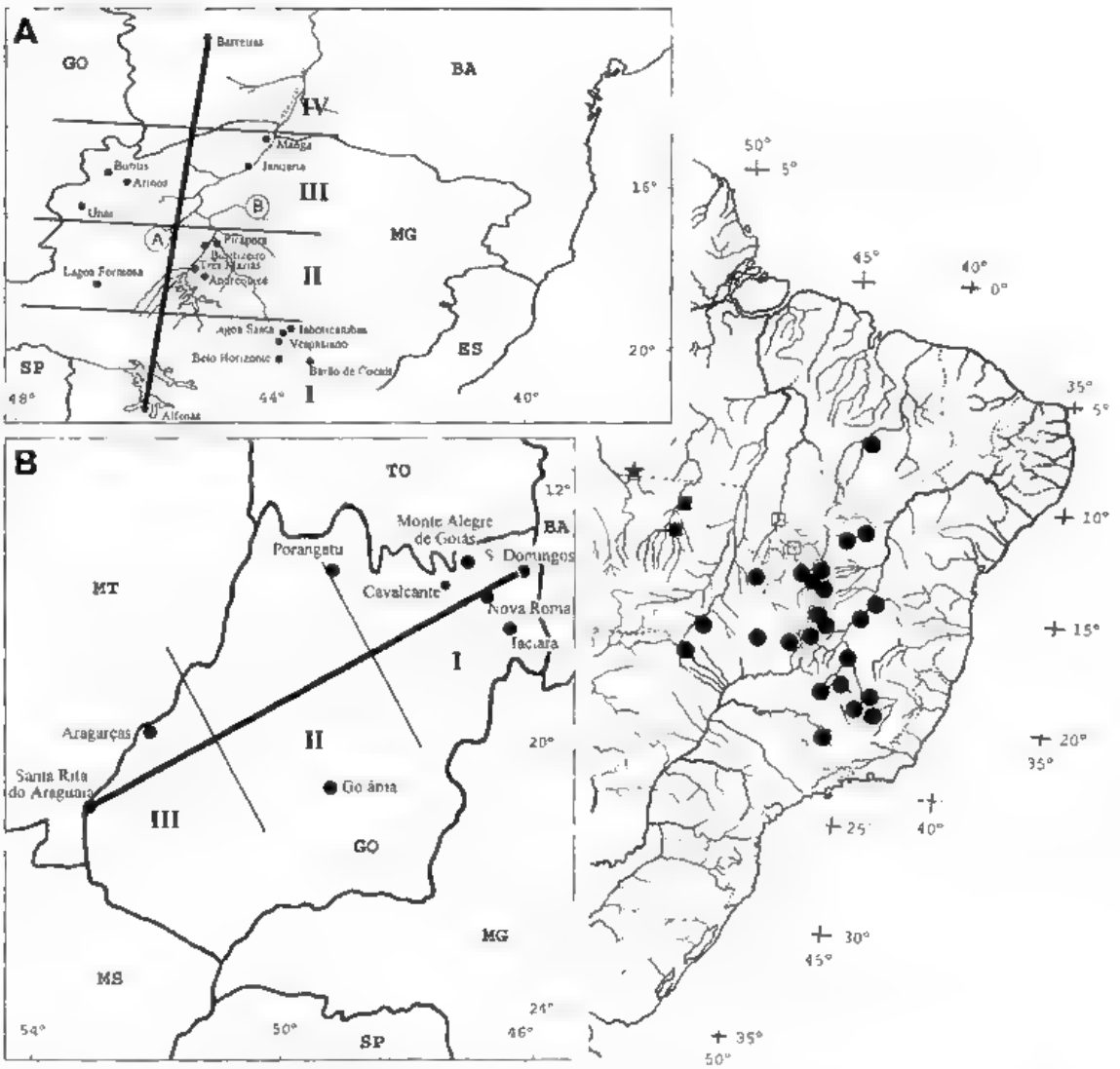


Fig. 4. Geographic distribution of (circles) *Hyla rubicundula*, (squares) *H. anataliasiasi* and (stars) *H. cachimbo*. Each plot may represent more than one sample. Closed symbols show the localities of examined samples, and open symbols the localities of samples of *H. anataliasiasi* not examined in this paper. (A) Distribution of morphospecies RU in Minas Gerais and Bahia. A transect line links Barreiras and Alfenas, the distribution limits north and south for RU. Shading areas A and B show directions of morphological variation explained in text (see *Variation within morphospecies RU*). (B) Distribution of morphospecies PRU in Goias. A transect line links São Domingos and Santa Rita do Araguaia, the distribution limits north and south for PRU. For detailed explanation of each character involved, see *Variation within morphospecies PRU*. BA, Bahia, ES, Espirito Santo, GO, Goias; MG, Minas Gerais, MS, Mato Grosso do Sul, MT, Mato Grosso, SP, São Paulo, TO, Tocantins. Roman numerals indicate areas equidistantly distributed throughout the transect.

RU and PRU which occur only in cerrado habitats. The greatest morphological similarity between these two morphospecies occurs right in the cerrado corridors that allow interactions between populations of RU in Minas Gerais and Bahia and PRU in Goias. We conclude that both morphospecies RU and PRU belong to *Hyla rubicundula*.

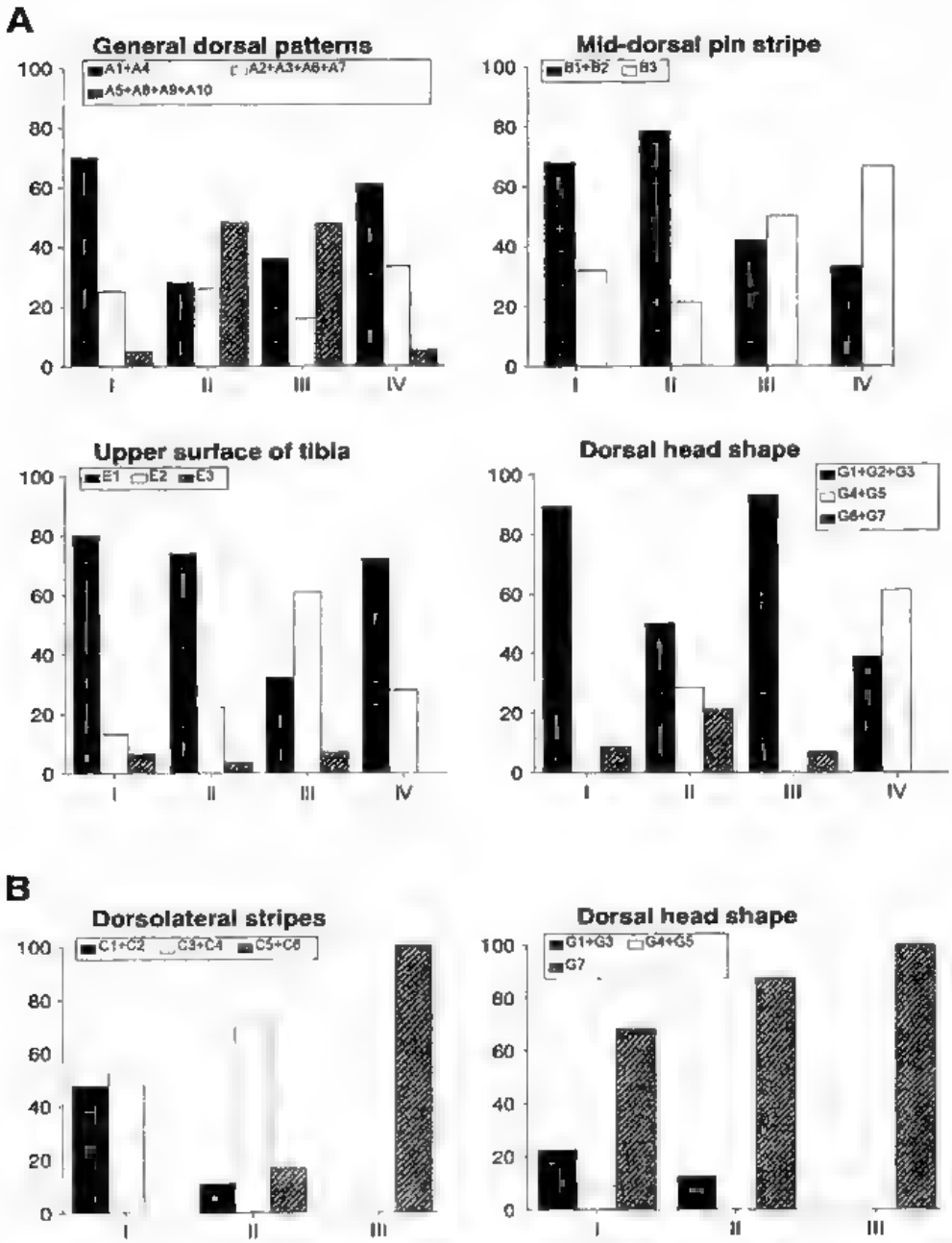


Fig. 5 Frequency (in percentage) of patterns obtained in morphospecies (A) RU and (B) PRU for areas I-IV (fig. 4A) and areas I-III (fig. 4B) respectively. Patterns were combined (for criteria, see app. 1) in order not to violate minimum cell-size requirements for chi-square analysis.

Morphospecies ANA (*Hyla anataliasiasi*) and CBO are well discriminated from each other and from the other two morphospecies (*Hyla rubicundula*) by the analyses of external morphology and morphometrics. Morphospecies CBO is restricted to an isolated savanna which is separated from cerrado by 200 km of tropical rainforest and was probably connected to the cerrado during periods of drier climate (Pleistocene; PRANCE, 1996). As we stated, these frogs never cross tropical rainforests, thus, this geographic isolation obstructs genetic flow and

Table 2. - Classification table for specimens based on the results of the discriminant function analysis for the combined samples RU, PRU, CBO, and ANA; Results presented graphically in fig. 5. *n* = number of specimens.

Morphospecies	*n*	RU	PRU	CBO	ANA
RU	124	96 (77.42%)	23 (18.55%)	4 (3 23%)	1 (0.81%)
PRU	41	5 (12 20%)	33 (80.49%)	3 (7.32%)	0
CBO	12	0	0	12 (100%)	0
ANA	65	0	0	0	65 (100%)

suggests a speciation mechanism. Morphospecies CBO and ANA may be considered full species, and we assigned the following morphospecies to these species: morphospecies RU and PRU to *Hyla rubicundula* Reinhardt & Lütken, 1862, morphospecies ANA to *Hyla anataliasiasi* Bokermann, 1972; and morphospecies CBO to a new species described below.

Species descriptions

Hyla cachimbo sp. nov.

(fig. 6A, 7A, 8A)

Holotype. MZUSP 21912, adult male, collected at Cachimbo (about 09°21'S, 54°57'W), Pará, Brazil, between 200 and 400 m, 18 October - 9 November 1955, by E. Dente, F. S. Pereira and W. Bokermann

Paratopotypes. – Thirteen adult males (MNRJ 17298-17299; MZUSP 21911, 21913-21918, 21920-21926) and an adult female (MZUSP 21910), collected with the holotype.

Diagnosis. – Species characterized by the following combination of traits. (1) small size (SVL: males 19 8-21.0 mm; female 24.2 mm); (2) lateral limits of dorsum above the tympanum (pattern D2, fig. 2); (3) head as long as wide, width contained about 3.1 times in the snout-vent length; and (4) dorsal snout profile acuminate (fig. 6A, 7A)

No specimen of *H. cachimbo* has two divergent dorsal brown stripes from the anterior section of head to near the middle of the body nor two parallel sacral stripes, but many individuals of *H rubicundula* have such a pattern (patterns A1, A2, A4-A6 and A8-10, fig. 1). No specimen of *H cachimbo* has a mid-dorsal pin stripe, but many individuals of *H rubicundula* have such a pattern (fig. 1) No specimen of *H. cachimbo* has the lateral limits of dorsum under the lower border of tympanum (pattern D2; fig. 2), but many individuals of *H rubicundula* from Goiás have such a pattern. No specimen of *H cachimbo* has a light pinkish to white stripe above a brown stripe on the edges of the tibia (pattern E1; fig. 2), but many individuals of *H rubicundula* have such a pattern; also, no specimen of the former has a thin

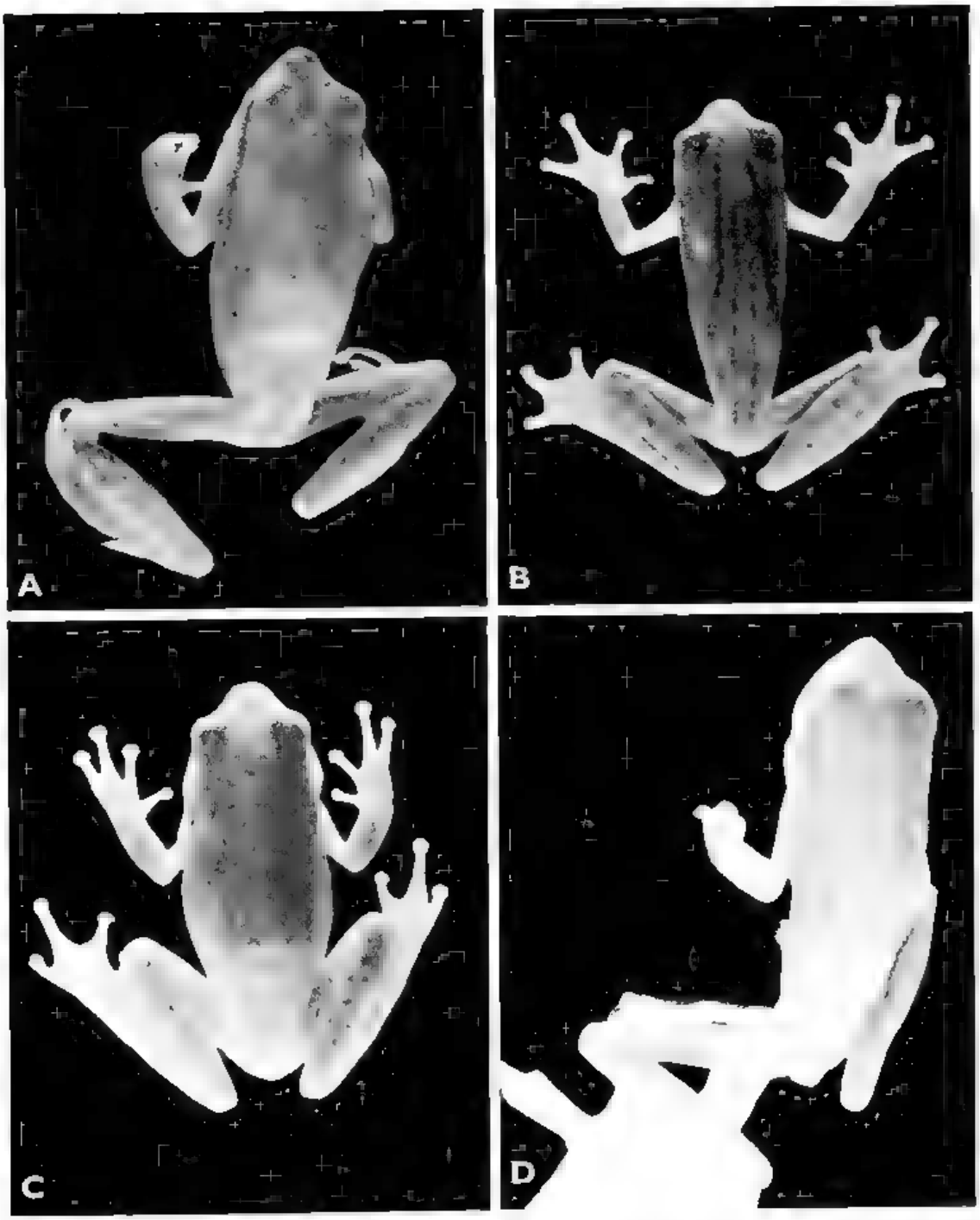


FIG 6 Dorsal views of adult males. (A) *Hyla cachimbo*, holotype, MZUSP 21912, Cachimbo, Para, (B) *H rubicundula*, MNRJ 17294, Lagoa Santa, Minas Gerais, (C) *H rubicundula*, MNRJ 17295, Goiânia, Goiás, (D) *H anataliasiasi*, MZUSP 49610, Posto Diauarum, Mato Grosso.

Table 3 - Standardized discriminant function coefficients for 18 morphometric characters of the combined samples of morphospecies RU, PRU, CBO and ANA. *r*, correlation coefficient (Pearson) of the original data with the scores resulted from the discriminant function analysis; ^{ns}, not significant; * P < 0.05; ** P < 0.02, *** P < 0 01.

Characters	VC1	VC2	VC3	$r_{(VC1)}$	$r_{(VC2)}$	$r_{(VC3)}$
SVL	0.55	- 0.41	- 0.59	0.73^{***}	$- 0.24^{***}$	0.15^{***}
HW	- 0.85	0.22	- 0.03	0.9^{***}	$- 0.11^{ns}$	0.05^{ns}
HL	0.45	0.12	0.39	0.78^{***}	$- 0.07^{ns}$	$- 0.04^{ns}$
ED	- 0.15	0.43	- 0.65	$0 55^{***}$	0.16^{***}	0.37^{***}
UEW	- 0.17	- 0.68	0.11	0.69^{***}	$- 0.45^{***}$	0.07^{ns}
IOD	- 0.34	- 0.14	0.31	0.69^{***}	0.01^{ns}	$- 0.09^{ns}$
END	- 0.44	0.33	- 0.05	0.82^{***}	$- 0.01^{ns}$	$- 0.01^{ns}$
IND	- 0.25	- 0.21	0.42	0.81^{***}	$- 0.08^{ns}$	$- 0.25^{***}$
THL	- 0.53	0.81	- 0.68	0.81^{***}	$- 0.09^{ns}$	0.09^{ns}
TL	0.96	- 0.12	1.83	0.7^{***}	$- 0.16^{***}$	$- 0.04^{ns}$
TD	0.16	- 0.18	- 0.23	0.17^{***}	$- 0.03^{ns}$	0.26^{***}
NSD	0.3	0.34	0.08	0.7^{***}	0.04^{ns}	$- 0.14^{**}$
UAR	0.14	0.39	- 0.18	0.58^{***}	0.02^{ns}	0.06^{ns}
FAR	- 0.12	- 0.28	0.19	0.67^{***}	$- 0.2^{***}$	0^{ns}
HAL	- 0.18	0 33	0.07	0.79^{***}	$- 0.05^{ns}$	0.14^{**}
3FD	- 0.37	0.25	0.15	0.85^{***}	$- 0.07^{ns}$	0.01^{ns}
FL	- 0.01	- 1.54	- 0.98	0.79^{***}	$- 0.28^{***}$	0.12^{*}
4TD	0.03	0.15	- 0.24	0.82^{***}	$- 0.06^{ns}$	$0 13^{*}$

longitudinal central brown stripe composed of small dots, whereas many individuals of *H anataliasiasi* have such a pattern (pattern E4). The presence in *H cachimbo* of a broad pinkish stripe above a canthal brown stripe (patterns F2-F3; fig 2) distinguishes it from *H. anataliasiasi* which presents a canthus well delimited by a thin white stripe above a brown stripe (pattern F1). A pointed snout (fig. 6A, 7A) differentiates *H cachimbo* from *H rubicundula* (fig. 6B-C, 7B-C). The head of the former is as long as wide, about 3.1 times into the snout-vent length, and this feature distinguishes it from *H anataliasiasi* which has a head longer than wide, its width being contained about 3 6 times in the snout-vent length

Description. Descriptive statistics are provided in tab. 4 Head as long as wide, its width contained about 3.1 times in snout-vent length; internarial distance greater than eye-nostril distance (n = 15, t – 2.76, P = 0 01) and smaller than eye diameter (n − 15, t = 20.66, P = 0); eye diameter greater than eye-nostril distance (n – 15, t – 19 68, P = 0), snout acuminate in

Table 4. - Descriptive statistical tables of morphometric characters for *Hyla cachimbo* sp. nov (morphospecies CBO) and *H. anataliasiasi* (morphospecies ANA) *n* = number of specimens for which data are available; *x* = mean; *s* = standard deviation; *CV* = coefficient of variation.

	Morphospecies CBO							Morphospecies ANA										
Characters	Males						Females	Males						Females (*n* = 4)				
	n	*x*	*min*	*max*	*s*	*CV*	(*n* = 1)	*n*	*x*	*min*	*max*	*s*	*CV*	*x*	*min*	*max*	*s*	*CV*
SVL	15	20 74	19 8	21 0	0.64	3 11	24 2	80	18 85	16.0		1 51	8.03	19 70	16.6	21.6	2 24	11 39
HW	15	6 39	6.0	6.8	0.25	3 94	7 7	80	5 28	4.4	21 8	1 40	7 72	5.46	4.6	6 1	0.65	12.01
HL	15	6 49	6 2	6 8	0.21	3 23	7 7	80	5 68	4 7	6 1	0.40	7.05	6 07	5 4	6.8	0.59	9.84
ED	15	2 38	2 2	2 6	0 12	5 23	2 5	80	2 19	1 9	6.5	0.10	4 56	2.27	2.0	2 4	0.15	6 83
UEW	14	1 41	1 2	1 7	0 14	10 12	1.7	77	1.22	0 9	2 4	0 16	13.21	1.15	1.0	1 2	0 09	7.93
IOD	14	2 29	2 0	2 6	0 16	7 36	2 5	78	1 84	1 4	2 2	0 16	9 03	1 95	1 7	2 2	0.22	11 65
END	15	1 54	1.4	1 8	0 10	7 02	1 7	80	1 21	1.0	2 2	0 11	9 66	1 33	1.1	1 6	0 18	14 11
IND	15	1 63	1 5	1 7	0 06	6 95	1 8	80	1 27	1 0	1 6	0 11	8 82	1 32	1.2	1 4	0.09	7.22
THL	15	9 90	9 3	10 5	0 35	3 59	12 5	80	8.38	7 1	1 5	0.69	8.32	8.88	7 3	10.0	1.24	14 01
TL	15	10 01	9.4	10 6	0.33	3.34	12 4	80	8.80	7 5	10.1	0.78	8 86	9 25	7.8	10.5	1 13	12 31
TD	14	1 00	0 8	1 1	0 09	9 6	1 1	73	0 91	0 6	10.6	0.12	13 44	0 87	0 6	1 0	0 16	18 95
NSD	15	1 19	1 0	1 3	0 08	7.14	1 3	80	0 93	0.7	1 4	0 08	9 10	0 92	0.8	1 0	0 08	9 36
UAR	15	6 00	5.7	6 4	0 22	3.71	7.0	80	5.27	4.4	1 1	0.42	8 02	5 35	4.8	5 8	0,45	8 46
FAR	15	3 87	3 6	4 2	0 19	4 95	5 1	80	3.37	2.8	6 3	0.29	8 68	3 43	3 0	3.9	0.39	11.5
HAL	15	5 91	5 5	6.2	0 22	3 72	7 5	80	4 92	4 0	4 0	0.43	8 92	5 13	4.5	5 7	0.54	10.70
3FD	15	0 88	0.7	1 0	0 07	8 10	1.0	80	0 65	0.5	5 9	0.08	12 83	0.71	0 5	0 8	0.11	16.58
FI	15	14 10	13 1	15.1	0.56	3 99	18 9	80	12.31	10.3	0 8	1.12	9 09	13.43	11.0	15.1	1 81	13 53
4TD	15	0 81	0 7	0 9	0 06	8 47	1 0	74	0 59	0.4	14 9	0 08	14.50	0 58	0 5	0.6	0 07	12 76

dorsal outline and protruding or rounded in lateral outline; loreal region slightly oblique; eyes moderately prominent; tympanum distinct and nearly circular; a supratympanic fold being sometimes present, partially covering tympanum; nostrils dorsolateral; internarial region flat; vomerine teeth often present in two patches between choanae; tongue cordiform or ovoid, vocal sac single and subgular.

Forearm more robust and shorter than upper arm ($n = 15$, $t = 28.09$, $P = 0$); hands with a distinct palmar tubercle, subarticular tubercles rounded, distal tubercle of third finger bifid or rounded; distal tubercle of fourth finger always bifid; supernumerary tubercles present, third finger disk diameter greater than fourth toe disk ($n = 15$, $t = 5.72$, $P = 0$); modal webbing formula, I 2 50-2 50 II 2-2.25 III 2.75-2.25 IV. Legs slender; femur and tibia with about the same stoutness and length ($n = 15$, $t = 0$ 87, $P = 0.39$); sum of thigh and tibia lengths smaller than snout-vent length ($n = 15$, $t = 3.42$, $P = 0$). Foot with robust toes; subarticular tubercles always rounded, supernumerary tubercles not distinct; prehallux distinct; plantar tubercle distinct; modal webbing formula, I 2-2.25 II 1.25-2 25 III 1.25-2.75 IV 3-1.75 V.

Color in preservative. - Dorsum reddish, immaculate, with occasional dark brown dots; mid-dorsal pin stripe absent; canthus rostralis delimited by a subcanthal brown stripe (patterns F2-F3; fig. 2); lorus with variable melanization; a slender lateral brown stripe sometimes present on flanks from posterior corner of orbit to near groin, sometimes bordered by a light pinkish stripe (patterns C2-C3; fig. 2), thigh light brown, immaculate; a brown stripe sometimes present on anterior and posterior edges of upper surface of tibia in addition to dorsal random dots (patterns E2-E3; fig. 2); ventral surfaces immaculate buff Color in life unknown.

Measurements of holotype. – SVL 21.3; HW 6.8, HL 6.8; ED 2.4; UEW 1 4; IOD 2.6; END 1 7; IND 1.5; THL 10.5; TL 10.6, TD 1 0; NSD 1.1; UAR 6.4; FAR 4.2, HAL 6 2, 3FD 0.9; FL 15.1; 4TD 0.8

Etymology. – The specific name, a noun in apposition, refers to the type-locality, Cachimbo.

Geographic distribution. – Known only from the type-locality (fig. 4). This area is characterized as an "ecological stress area" (Anonymous, 1991) or a transitional area between the Cerrado Domain and the Amazon Equatorial Domain (Ab' Saber, 1977).

Hyla rubicundula Reinhardt & Lütken, 1862

(fig. 6B-C, 7B-C, 8B-C)

Hyla rubicundula Reinhardt & Lütken, 1862; Bokermann, 1968, 1972.

Specimens examined BRAZIL. Bahia: Barreiras (MNRJ 0934, 0946, 0935-0940, 0933, 6145-6154), Jupaguá (MNRJ 0943-0944). Minas Gerais: Alfenas (MNRJ 17126-17128, 17129-17133, 17134); Andrequicé (MNRJ 17110); Arinos (MZUSP 64500-64504), Barão de Cocais (MNRJ 17210-17212), Belo Horizonte (MNRJ 17214-17220, MZUSP 519, 34647); Buritis (MZUSP 64449-64452, 64455-64458, 64460-64464), Buritizeiro (MNRJ 17111-17112, 17113-17116); Esmeraldas (ZUEC 4023); Jaboticatubas (MZUSP 57712-57713), Januária (MNRJ 0942), Lagoa Formosa (MNRJ 17123); Lagoa Santa (topotypes, MNRJ 17117-

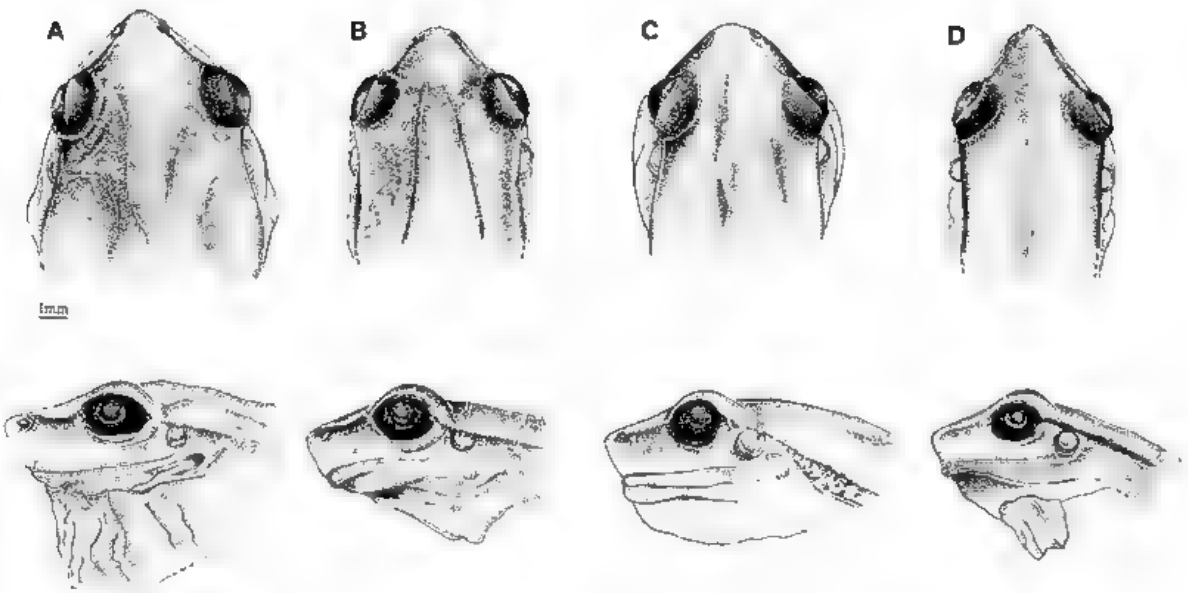


Fig. 7 Dorsal and lateral views of the heads of adult males. (A) *Hyla cachimbo*, holotype, MZUSP 21912, Cachimbo, Para, (B) *H. rubicundula*, topotype, morphospecies RU, MNRJ 17294, Lagoa Santa, Minas Gerais; (C) *H. rubicundula*, morphospecies PRU, MNRJ 17295, Goiânia, Goias, (D) *H. anataliasiasi*, MZUSP 49610, Posto Diauarum, Mato Grosso

17121, 17124-17125, 3081, 13287, 0947, 6155-6177; MZUSP 34012-34023; ZUEC 4150), Manga (MNRJ 0941); Pimenta (MNRJ 17319-17321), Pirapora (MNRJ 0928-0932, 0945, 0923-0927), Santa Luzia (MNRJ 17322-17323); Três Marias (MNRJ 17101-17109), Uberlândia (MNRJ 17305-17308); Unaí (MZUSP 64398-64402, 64386, 64389-64392, 64396; MNRJ 17135), Vespasiano (MNRJ 17221-17223; MZUSP 12691-12693) GOIÁS: Aragarças (MZUSP 20983); Cavalcante (MZUSP 66543, 66570, 66574, 66576), Cristalina (MZUSP 64522), Goiânia (MNRJ 17136-17155, 17300), Iaciara (MZUSP 66527-66528), Monte Alegre de Goiás (MZUSP 66403-66407, 66450, 66456); Nova Roma (MZUSP 66358-66360), Porangatu (MNRJ 17167-17168), Santa Rita do Araguaia (MZUSP 66650-66654), São Domingos (MZUSP 66597-66601, 66602, 66603); escarpa da Serra Dourada (ZUEC 7505) PIAUÍ: Uruçuí (MNRJ 17224).

Syntypes. NMW 16511, ZMUC 1440-1441, Lagoa Santa (about 19°37'S, 43°53'W), Minas Gerais, Brazil, 760 m (BOKERMANN, 1968; FROST, 1985), specimens not examined by us.

Diagnosis. - Species characterized by the following combination of traits: (1) small size (SVL males 18.0-23.4 mm, females 21.6-25.1 mm); (2) in preservative, dorsum with two divergent brown stripes from anterior section of head to sacral region, and two sacral stripes of same color and orientation extending to cloacal region (pattern A1; fig. 1), (3) a thin brown dorsolateral stripe bordered by a thin light stripe from posterior corner of orbit to near groin (pattern C1, fig. 2); and (4) head as long as wide, its width contained about 3.3 times in snout-vent length (fig. 6B-C, 7B-C)

The presence of dorsal brown stripes (patterns A1-A2, A4-A6 and A8-A10; fig. 1) in many individuals of *Hyla rubicundula* differentiate them from *H. cachimbo* which never has such a pattern. The presence in many specimens of the former of two divergent dorsal brown stripes, from the anterior section of the head to nearly the middle of the body, together with two sacral brown stripes (patterns A1 and A4; fig 1), with or without additional brown stripes (patterns A5 and A8-A10), distinguish them from *H. anataliasiasi*, which do not have such patterns. No specimen of *H rubicundula* has the two anterior divergent dorsal brown stripes fused to the sacral ones (pattern A11), whereas many individuals of *H. anataliasiasi* have such a pattern. A mid-dorsal pin stripe (patterns B1-B2; fig. 1) in many specimens of *H. rubicundula* distinguish them from *H. cachimbo*, in which it is often absent. A broad and irregular dorsolateral stripe, with or without an upper white to pinkish stripe (patterns C3-C4, fig. 2) in many specimens of *H. rubicundula* distinguishes them from *H anataliasiasi*, which never has such a pattern The lateral limits of the dorsal coloration in many specimens of *H. rubicundula* are under the lower border of the tympanum (pattern D2; fig 2), whereas *H. cachimbo* and *H. anataliasiasi* often have this limit above the tympanum (pattern D1), a pattern common to the three species. The presence of a thin white to pinkish stripe on the edges of the tibia above a thin brown stripe (pattern E1; fig 2) in many specimens of *H. rubicundula* distinguishes them from *H. cachimbo*, which never has such a pattern; also, no specimen of *H. rubicundula* has a thin longitudinal central brown stripe on the upper surface of tibia composed of thin dots (pattern E4), whereas many individuals of *H. anataliasiasi* have such a pattern. The presence in *H. rubicundula* of a thin pinkish to white canthal stripe above a brown loreal stripe (pattern F1; fig. 2) distinguishes it from *H cachimbo* which lacks such a pattern; also, the presence in many specimens of the former of a broad canthal pinkish stripe above a brown loreal stripe (patterns F2-F3) distinguishes them from *H. anataliasiasi*, which never has such a pattern. *Hyla rubicundula* has a truncate or rounded snout (fig. 6B-C, 7B-C), whereas *H. cachimbo* has an acuminate snout (fig. 6A, 7A), also, the former has a head as long as wide, its width being contained about 3.3 times in the snout-vent length, and *H anataliasiasi* has a head longer than wide, its width being contained about 3 6 times in the snout-vent length.

Description The following description is based on topotypes and other geographic samples from Minas Gerais and Bahia (morphospecies RU). The morphotype located in central Brazil (morphospecies PRU) is characterized in the geographic variation section.

Descriptive statistics are provided in tab. 5 Head as long as wide ($n = 140$, $t = 1.65$, $P = 0\ 09$), its width contained about 3.3 times in snout-vent length; internarial distance greater than eye-nostril distance ($n = 139$, $t = 4.61$, $P = 0$) and much smaller than eye diameter ($n = 139$, $t = 50.29$, $P = 0$); eye diameter greater than eye nostril distance ($n = 139$, $t = 53\ 66$, $P = 0$); canthus rostralis distinct, slightly rounded; lorus slightly oblique, sometimes perpendicular to canthus rostralis; eyes slightly to very prominent, tympanum distinct and nearly circular; supratympanic fold poorly developed; nostrils dorsolateral, slightly protuberant, directed laterally or slightly forward, internarial region furrowed or not, vomerine teeth in two patches between choanae, with irregular shape and position, tongue cordiform or rounded, vocal sac single and subgular.

Forearm more robust and shorter than upper arm ($n = 139$, $t = 40.64$, $P = 0$), hands with a distinct palmar tubercle, subarticular tubercles rounded, distal tubercle of fourth finger bifid, that of third finger bifid or rounded, supernumerary tubercles present, prepollex

Table 5 - Descriptive statistical tables of morphometric characters for *Hyla rubicundula* (morphospecies RU and PRU). *n* = number of specimens for which data are available, *x* = mean; *s* = standard deviation; *CV* = coefficient of variation

	Morphospecies RU											Morphospecies PRU										
Characters	Males						Females (*n* = 4)					Males						Females (*n* = 6)				
	n	*x*	*min*	*max*	*s*	*CV*	*x*	*min*	*max*	*s*	*CV*	*n*	*x*	*min*	*max*	*s*	*CV*	*x*	*min*	*max*	*s*	*CV*
SVL	140	21 27	18 0	23 4	0 97	4 58	23 75	21 6	25 1	1 52	6.43	47	21 67	18 1	23 8	1.09	5 07	23 93	22.2	25 4	1.43	5 98
HW	140	6 31	5 4	7 0	0 28	4.54	6 57	6.2	6.9	0 33	5 35	47	6.49	5 6	7 2	0.31	4 86	7 00	6.5	4 2	0.26	3 80
HL	140	6.37	5 5	7 1	0.27	4 36	6.81	6 5	7 1	0.33	4 88	47	6.45	5 7	7 0	0.26	4.15	7 05	6.5	7 4	0 30	4.37
ED	139	2 33	2 0	2 7	0 14	6.36	2 51	2 3	2 6	0.14	5 94	47	2.45	2 1	2 8	0 14	5 85	2 58	2.3	2.7	0.16	6.20
UEW	136	1 56	1 2	2 0	0 15	9 66	1 57	1.5	1.7	0 11	7.55	46	1.56	1.0	1 8	0.14	9.35	1 70	1 4	1 9	0.16	9 51
IOD	129	2 16	1 7	2 6	0.19	9 12	2.36	2.0	2.6	0 27	11 51	46	2.18	1.8	2 5	0.14	6.82	2.27	2 2	2 4	0 09	4 34
END	139	1 48	1 1	1 8	0 10	6 85	1 58	1 5	1 7	0.08	5 37	47	1 53	1 3	1 7	0.10	6.70	1 60	1 5	1 7	0 09	5 70
IND	139	1 55	1 1	1 8	0.10	6.85	1.58	1.5	1 7	0.11	6.98	47	1 54	1 3	1 8	0 09	6.08	1 70	1 5	1 8	0.08	5.26
THL	137	9 81	8 0	12 1	0 56	5 77	10.61	9 4	11 1	0.78	7 37	47	10.08	8 5	11 3	0.60	6.08	11.15	10.3	11 8	0 51	4.66
TL	140	9 99	8 3	11 1	0 48	4 88	10.76	9 7	11.3	0.73	6.85	47	10.05	8.3	11.1	0.58	5 85	11.04	10.2	11 5	0 59	5 36
TD	138	0 97	0 6	1 4	0.11	12 17	1 12	1 0	1 2	0.18	13 26	44	1 03	0 8	1 2	0.08	8 24	1 27	0.9	1 8	0.31	25 01
NSD	139	1 11	0 9	1 8	0.11	10 41	1.15	0 9	1 3	0.18	16.26	47	1 13	0 9	1 2	0.08	7 25	1 21	1 1	1 3	0.07	5 12
LAR	139	5 83	4 4	7 2	0.47	8 07	6.28	6 0	6.5	0.22	3 57	47	5 99	5 1	6 7	0.40	6.42	6.58	6.0	6.9	0.33	5.12
PAR	139	3 90	3 1	4 9	0 30	7 37	4 31	3 8	4 6	0 35	8 16	47	3 92	3 4	4 5	0 25	6.42	4.14	3 7	4 6	0.30	7.45
HAL	139	5 84	4 4	7 0	0.43	7 38	6 28	6 0	6 4	0 19	3 07	47	6.11	5 3	7 4	0.39	6.53	6.60	6 0	6 9	0 34	5.22
3FD	139	0 86	0 6	1 1	0.07	9 27	0 96	0 8	1 0	0 08	8 87	46	0 89	0 6	1.0	0.08	9 02	0.97	0.8	1 1	0.09	9.59
FI	139	14 61	11 7	16 3	0 76	5 26	15 72	14 3	16 5	0 96	6 14	47	14 89	12 2	17 4	14.89	1 00	16.20	15.0	17 4	1 01	6.26
4TD	139	0 80	0 5	1 0	0 09	11 68	0 87	0 8	0 9	0 06	7 37	47	0 84	0 6	1 0	0 09	11 57	0 88	0 7	1.0	0 10	11 69

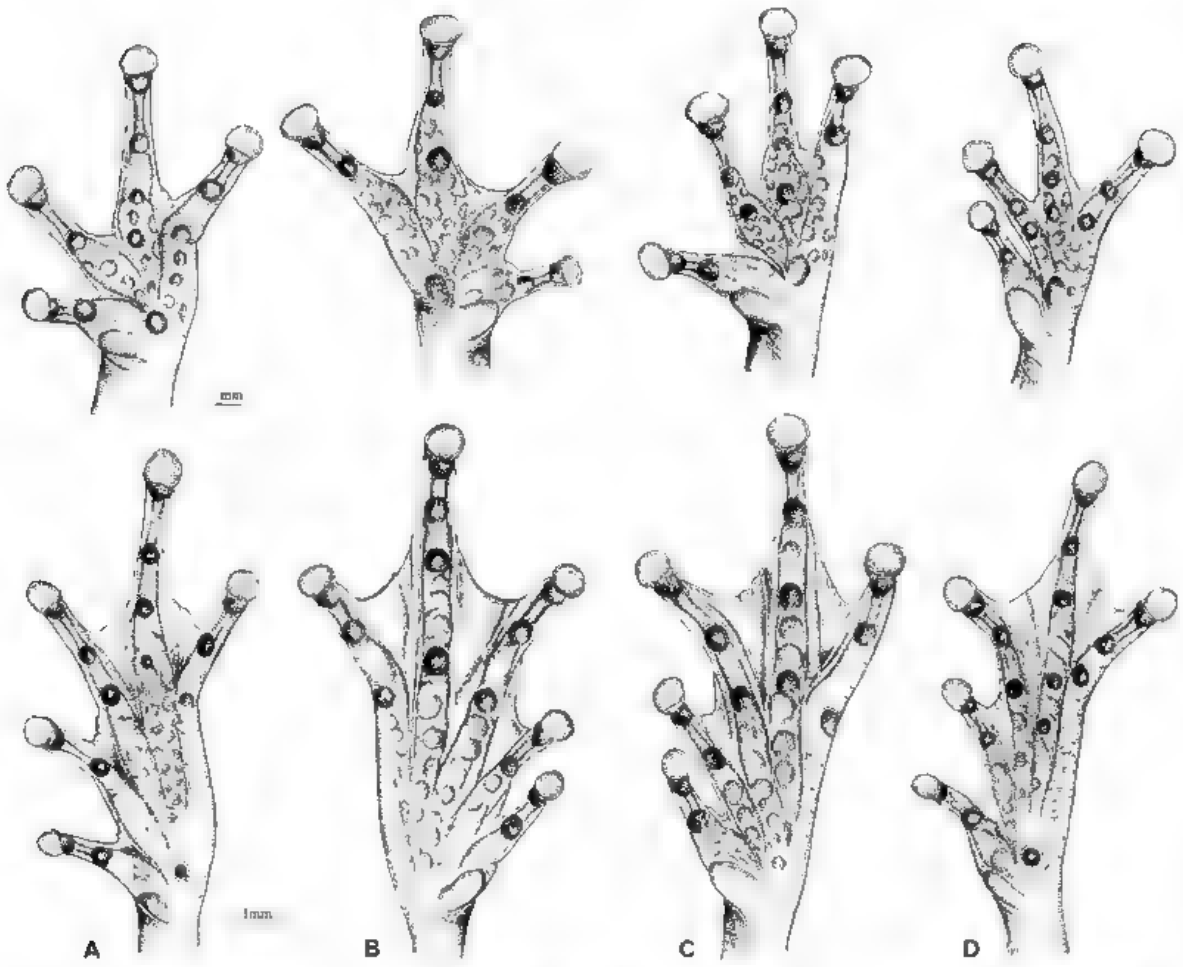


Fig 8 Hands and feet of adult males. (A) *Hyla cachimbo*, holotype, MZUSP 21912, Cachimbo, Para, (B) *H rubicundula*, topotype, morphospecies RU, MNRJ 17294, Lagoa Santa, Minas Gerais; (C) *H rubicundula*, morphospecies PRU, MNRJ 17295, Goiânia, Goiás, (D) *H anataliasiasi*, MZUSP 49610, Posto Diauarum, Mato Grosso.

distinct, third finger disk diameter greater than fourth toe disk ($n = 139$, $t = 5.72$, $P = 0$); modal webbing formula, I 2.75-2.75 II 2-3 25 III 3-2.25 IV. Legs slender; femur and tibia with about the same stoutness; femur length shorter than tibia length ($n = 137$, $t = 2.88$, $P = 0$); sum of femur and tibia lengths smaller than snout-vent length ($n = 137$, $t = 12.20$, $P = 0$); toes not robust; subarticular tubercles rounded; supernumerary tubercles variable in shape and number; prehallux distinct, modal webbing formula, I 2 -2 25 II 1^{+}-2 25 III 1^{+}-2 25 IV 2 25-1^{+} V.

Color. In life, the analysis of four topotypic specimens from Lagoa Santa (Minas Gerais) revealed that in the same specimen the dorsal surfaces vary from dark green to dark brown, with an intermediate yellow phase, dots and dark brown stripes are not visible on the dorsum; a dark brown stripe, bordered by a white stripe, is visible on the flanks and canthus rostralis, thigh light brown and immaculate, vocal sac yellowish, belly white; finger and toe disks reddish

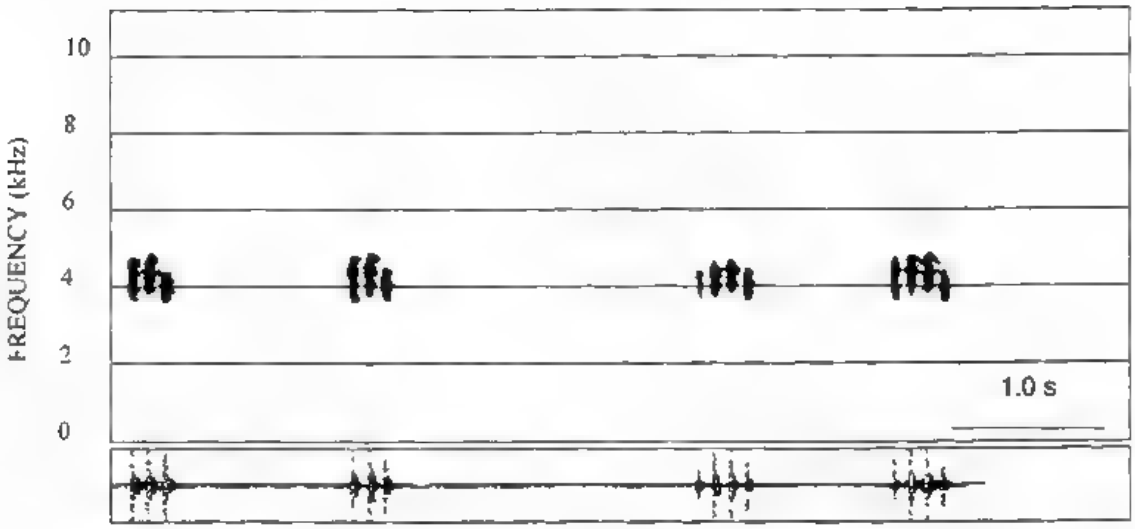


Fig 9. Sonogram and oscillogram of advertisement call of *Hyla rubicundula* (morphospecies PRU) from Silvânia, Goiás. Calls are given sporadically. The intervals between the notes are not natural

In preservative, dorsum reddish, with occasional dark brown stripes and dots (patterns A1-A10; fig 1); a mid-dorsal pin-stripe sometimes present on dorsum (patterns B1-B2; fig. 1); canthus rostralis delimited by a dark subcanthal brown stripe bordered above by a light pink to white stripe (pattern F1; fig 2); lorus with a variable degree of melanization; dorsolateral region delimited by a dark brown stripe bordered above or not by a light pink to white stripe from posterior corner of orbit to near groin (patterns C1-C2 and C5; fig. 2), both often above tympanum (pattern D1; fig. 2); thigh light brown, immaculate; a brown stripe sometimes present on anterior and posterior edges of tibia in addition to random dots (patterns E1-E3; fig. 2); ventral surfaces immaculate buff.

Geographic variation Samples from central Brazil (morphospecies PRU) have the following differences when compared to samples from Minas Gerais and Bahia (morphospecies RU). dorsal head shape pattern with pattern A7 (fig. 3, 6C, 7A); internarial distance and eye-nostril distance nearly equal ($n = 47$, $t = 0.26$, $P = 0.79$); lorus slightly to strongly concave, tympanum covered or not by a supratympanic fold, distal tubercle of fourth finger bifid or not, femur and tibia the same length ($n = 47$, $t = 0.22$, $P = 0.82$); dorsolateral stripes pattern corresponding to patterns C3-C4 (fig 2); lateral limits of dorsal pattern corresponding to pattern D2 (fig. 2). The other variations are of a matter of degree (tab. 1) and descriptive statistics are presented in tab. 5

Vocalization The advertisement calls studied are from one specimen from Silvânia, Goiás (morphospecies PRU; fig 9) Each note composed of three pulses had a duration of nearly 0 03 s, and each note was composed of four pulses about 0.04 s. Broadcast frequencies range between 3.5 and 4 8 kHz Air temperature was 21 5°C. CARDOSO & VIELLIARD (1985) gave a

detailed description of the call of *Hyla rubicundula* from Lagoa Santa, the type-locality of morphospecies RU. Comparisons between the two vocalizations reveal that they are very similar and that both belong to *H. rubicundula*.

Geographic distribution. *Hyla rubicundula* occurs in Minas Gerais, Goiás, Bahia and Piauí (fig. 4), mainly in the Cerrado Domain (Ab' Saber, 1977), and never crosses tropical rain forests.

Hyla anataliasiasi Bokermann, 1972

(fig. 6D, 7D, 8D)

Specimens examined. – BRAZIL. Mato Grosso: Posto Diauarum (MZUSP 49588-49617), Posto Leonardo (MZUSP 49339-49393).

Holotype. - WCAB 45272, adult male, collected at Belém-Brasília highroad, 80 km before Paraíso do Norte, Brejinho de Nazaré (about 11°00'S, 48°33'W), Goiás [Tocantins], Brazil, 247 m, 17 January 1970, by C. A. Bokermann, Ladislau A. Deutsch and Milton S. Carollo.

Paratypes. Four adult males: WCAB 45273, collected with the holotype; WCAB 45256-45258, collected at Paranã (about 12°36'S, 47°52'W), Goiás [Tocantins], Brazil, 274 m, December 1969, by Anatalias J. Rodrigues.

Diagnosis. – Species characterized by the following combination of traits: (1) small size (SVL: males 16.0-21.8 mm; females 16.6-21.6 mm); (2) dorsum with nearly parallel dark brown stripes, the two anterior ones very near each other, joined with the two sacral ones (pattern A11; fig. 1); and (3) head longer than wide, its width being contained about 3.6 times in snout-vent length (fig. 6D, 7D).

The presence of two anterior dorsal brown stripes fused to the sacral ones in some specimens of *H. anataliasiasi* (pattern A11, fig. 1) distinguishes them from *H. rubicundula* and *H. cachimbo*, which lack such a pattern; also, the absence in the former of two divergent dorsal brown stripes, from the anterior section of head to nearly half of the dorsum, barely separated from two sacral brown stripes (patterns A1 and A4), with or without additional dorsolateral stripes (patterns A5 and A8-A10), distinguishes it from *H. rubicundula*, which has many individuals with such patterns. A mid-dorsal pin stripe (patterns B1 and B6, fig. 1) in many specimens of *H. anataliasiasi* distinguishes them from *H. cachimbo* in which stripes are absent. A well-marked dark brown to black dorsolateral stripe under a thin white stripe (pattern C7; fig. 2) in some specimens of *H. anataliasiasi* distinguishes them from *H. rubicundula* and *H. cachimbo* which never possess such a pattern; also, the absence in the former of a broad and irregular brown dorsolateral stripe, with or without an upper white to pinkish stripe (patterns C3-C4), distinguishes it from many individuals of *H. rubicundula* with such patterns. No specimen of *H. cachimbo* has the lateral limits of the dorsal coloration below the lower border of the tympanum (pattern D2; fig. 2), but many individuals of *H. rubicundula* from Goiás have such a pattern. The presence in some specimens of *H. anataliasiasi* of a thin white to pinkish stripe on the edges of tibia, above a thin brown stripe (pattern

E1; fig. 2), distinguishes them from *H. cachimbo*, which never has such a pattern; also, the presence in the former of a thin longitudinal central brown stripe on the upper surface of tibia, composed of small dots (pattern E4), distinguishes it from *H. rubicundula* and *H. cachimbo* which never possess such a pattern. No specimen of *H. anataliasiasi* has a broad canthal pinkish stripe above a brown loreal stripe (patterns F2-F3; fig. 2), but many individuals of *H. rubicundula* and *H. cachimbo* have such a pattern. The snout in *H. anataliasiasi* is acuminate in many individuals (fig. 6D, 7D), but it is rounded or truncate in *H. rubicundula* (fig. 6B-C, 7B-C). In the former the head is longer than wide, its width being contained about 3.6 times in snout-vent length, whereas in *H. rubicundula* and *H. cachimbo* the head is as long as wide, its width being contained, respectively, about 3.3 and 3.1 times in snout-vent length.

Description. – Descriptive statistics are provided in tab. 4. Head longer than wide ($n = 80$, $t = 6.23$, $P = 0$), its width being contained about 3.6 times in snout-vent length; internarial distance greater than eye-nostril distance ($n = 80$, $t = 3.09$, $P = 0$) and much smaller than eye diameter ($n = 80$, $t = 54.51$, $P = 0$); eye diameter greater than eye-nostril distance ($n = 80$, $t = 56.35$, $P = 0$); snout truncate, rounded or acuminate in dorsal outline, and slightly protruding, truncate or rounded in lateral outline; canthus rostralis distinct, especially when bordered by loreal and canthal stripes, rounded or straight; lorus slightly concave; eyes moderately prominent, tympanum distinct, nearly circular; a supratympanic fold sometimes covering upper surface of tympanum; nostrils dorsolateral, slightly protuberant, directed laterally or slightly anteriorly; internarial region furrowed, vomerine teeth in two patches with irregular shapes and positions between choanae; tongue cordiform or rounded; vocal sac single, subgular, not well developed.

Forearm shorter and more robust than upper arm ($n = 80$, $t = 33.04$, $P = 0$), hands with a distinct palmar tubercle; subarticular tubercles distinct, rounded; distal tubercle of third and fourth fingers bifid or not; supernumerary tubercles present, palmar tubercle distinct; prepollex distinct, third finger disk diameter greater than fourth toe disk ($n = 74$, $t = 4.92$, $P = 0$); modal webbing formula, I 2.50-2.75 II 2.25-3.25 III 2.75-2.25 IV. Legs slender; femur and tibia with the same stoutness, femur longer than tibia ($n = 80$, $t = 3.60$, $P = 0$); sum of femur and tibia lengths smaller than snout-vent length ($n = 80$, $t = 8.57$, $P = 0$), foot with rounded subarticular tubercles, supernumerary tubercles not very distinct; prehallux distinct, plantar tubercle present or not, modal webbing formula, I 1.75-2.25 II 1^+-2.25 III 1.25-2.25 IV $3-1^+$ V.

Color. – In life, dorsal surfaces green (BOKERMANN, 1972). In preservative, dorsum reddish with occasional dark brown stripes and dots (patterns A2, A6 and A11; fig. 1); a mid-dorsal pin-stripe present or not (patterns B1-B2, fig. 2); canthus rostralis delimited, or not, by a subcanthal dark brown stripe bordered above by a light pink to white stripe (patterns F1-F3, fig. 2), lorus with a variable degree of melanization, a lateral brown stripe sometimes present on flanks from posterior corner of orbit to near groin, sometimes bordered by a light pinkish stripe (patterns C1-C2, C5 and C7; fig. 2), both often above tympanum (pattern B1; fig. 2); thigh light brown with numerous widespread light brown dots; a brown stripe sometimes present on anterior and posterior edges of upper surface of tibia, bordered by a light pink to white stripe, in addition to dorsal random dots (patterns E1 and E3; fig. 2), or with a thin longitudinal central stripe composed of small dots (pattern E4), ventral surfaces immaculate buff.

Geographic distribution. Recorded from Tocantins (Brejinho do Nazaré and Paranã; BOKERMANN, 1972) and northern Mato Grosso (Posto Diauarum and Posto Leonardo; fig. 4), both in the Cerrado Domain (AB' SABER, 1977) at elevations between 247 and 274 m

RÉSUMÉ

Le groupe d'espèces de *Hyla rubicundula*, composé de *H rubicundula* Reinhardt & Lütken, 1862 et *H. anataliasiasi* Bokermann, 1972, est subdivisé en quatre morpho-espèces. La variation intra- et inter-populationnelle de la morphologie externe de chaque morpho-espèce est analysée. *Hyla rubicundula* renferme trois des quatre morpho-espèces. Celle située au nord de sa répartition est décrite comme une espèce nouvelle, caractérisée principalement par un dos immaculé et un museau pointu. Une redescription est présentée pour les espèces *H rubicundula* et *H. anataliasiasi.*

ACKNOWLEDGEMENTS

We thank Mauro CAVALCANTI for aid in the statistical procedures, Ronald ALTIG, W Ronald HEYER, Ronaldo FERNANDES, José P. POMBAL Jr and Hussam ZAHER for their helpful comments on the manuscript, Paulo R NASCIMENTO for the drawings, Rogerio P. BASTOS for the recording of *Hyla rubicundula* from Goiás, and Celio F. B. HADDAD for the bioacoustic analysis. Adão J. CARDOSO and Paulo E. VANZOLINI permitted study of material under their care. For financial support, we are grateful to the CAPES and CNPq, and FAPESP (Proc 94/5634-5) for the aid to the Bioacoustic Laboratory of UNESP – Rio Claro, SP

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APPENDIX 1

Criteria for combination of patterns in analyses of interpopulation variation of morphospecies RU and PRU

Patterns were joined by similarity and geographic distribution.

General dorsal patterns. - A1 and A4 are typical from topotypic samples for *Hyla rubicundula*. Compared to patterns A1 and A4, A2, A3, A6 and A7 are incomplete, vestigial or absent, whereas A5, A8, A9 and A10 have additional melanization.

Mid-dorsal pin stripe patterns. - B1 and B2, presence; B3, absence.

Dorsolateral stripes. - C1 and C2, typical from Lagoa Santa, Minas Gerais; C3 and C4, typical from Goiás; C5 and C6, vestigial or absent; C7, only for *H. anataliasiasi*.

Dorsal head shape patterns. - G1-G3, typical from Lagoa Santa, Minas Gerais; G4-G5, typical from Barreiras, Bahia, G6-G7, typical from central Minas Gerais.

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